A Platform-independent, Generic-purpose, and Blockchain-based Supply Chain Tracking

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***Abstract*—Supply Chain Tracking (SCT) is considered as a major challenge for stakeholders of heterogeneous production, processing, transporting, storing, and selling systems. Studies on solutions in SCT reveal that many centralized SCT applications lack a design, which can support or even enable main features of a reliable, transparent, and publicly accessible SCT system for end users. This work demonstrates the implementation of a SCT application which, employs SC on the Ethereum blockchain (BC). This Decentralized Application (Dapp) provides a hardware-and platform-independent approach that flexibly enables multiple object combinations and transformations to be tracked with a use case-agnostic design and utilization.**

***Index Terms*—End-to-end Supply Chain Tracking, decentralized Application, Ethereum, Smart Contract, Blockchains**

I. Introduction

Today's decentralized data storage methodology, enabled by blockchains (BC), offers a platform for secure and anonymous transactions by using a decentralized network of computers. Blockchains are constructed by back-linked blocks of data, within the change of a single bit in any of these blocks stored will be revealed by every participant. Miners persist data within a BC. Thus, BC's cryptographic algorithms substituted electronically trust into traditional organizations, such as banks, insurance agencies, governments, and private individuals. A broad area of use cases will benefit from that in different degrees, and they include FinTech (cryptocurrencies, crowdfunding, peer-to-peer P2P payments), identity management (Know Your Customer KYC systems, DNA inventory, authentication), smart contracts (purchase and rental contracts), Governance (eVoting), cybersecurity (mitigating Distributed Denial-of-Service DDoS Attacks), and data storage (inventory of objects) [1], [2], [3], and [4].

Blockchains can support different applications. Users of BCs trust these systems even though they may not trust other parties of transactions. Among many BC use cases, Supply Chain Tracking (SCT) has risen high interest during past years due to the challenges of such integrated systems. Centralized SCT systems inherit general concerns of traditionally centralized systems, such as (a) being inaccessible for public access, (b) lack of trust to the stored data as data collection, storage, and analysis were all done only inside the supply chain autonomously, (c) end users' transparency requirements to track back one product's history especially in the food sector, and (d) ability to execute P2P payments between producers and end users.

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To fulfill these demands, this work demonstrates the implementation of a SCT Dapp termed ASPIR (pl**A**tform-independent, generic-Purpose, and blockchain-based **S**u**P**ply cha**I**n t**R**acking). ASPIR employs BC to provide trustable and transparent tracking, which enabled by a public access to the public Ethereum BC.

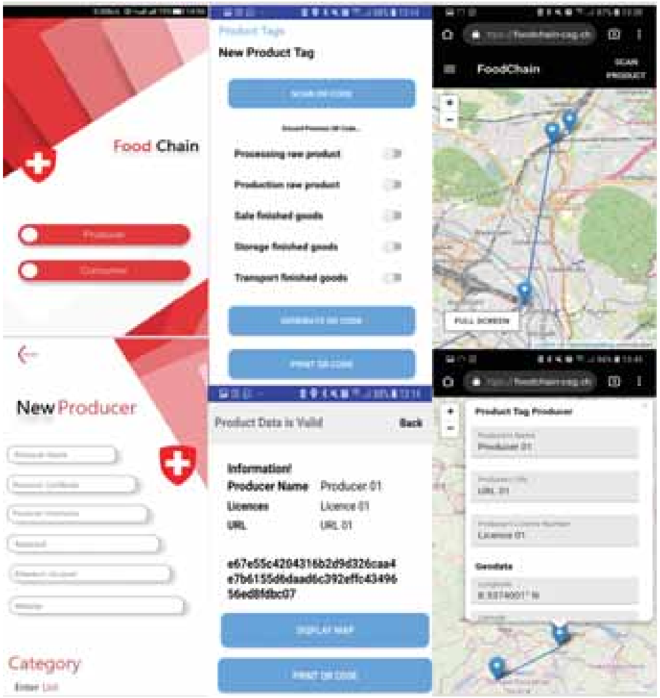

Fig. 1. Multiple Views of ASPIR

II. Implementation Overview

ASPIR offers actors (i.e., farmer, produces, transporters) the electronic selection and modification of certificates, product licenses, and actions at each step within a supply chain. For each step, all actors' location, date, time, action, and hash of all these data are collected. Furthermore, a QR (Quick Response) code is to be generated, printed, and attached to products where applicable. Users (*i.e.*, actors and end users) utilize iOS or Android smartphones (determining the platform independence) for registration, QR code generation, QR code scanning, and tracking products. A set of actions provided in the system even enables the selection of dedicated printer settings (*cf.* Figure 1).

ASPIR employs QR codes to store the states of products upon generation, transport, combination, and transformation. Inputs to ASPIR are provided by respective stakeholders, here the producer with the registration and QR code generation processes. This information includes (a) producer identity, (b) producer Website URL, (c) producer certificate(s), (d) product license(s), (e) producer Ethereum account, and (f) list of actions. All actions in ASPIR can be defined precisely by producers and selected when needed for generating QR codes. In contrast, end users do not need to register and use their smartphones to scan product tags for SCT information access. With a QR code scan, all relevant action points for one product, including all producers and steps performed for that specific product will be shown on the map view (*cf.* Figure 2).

Since ASPIR addresses supply chain use cases in this generic fashion, multiple product combinations are traceable, too. A brief functional evaluation of ASPIR reveals that in comparison to other related BC applications for the supply chain such as in [5], [6], and [7], it covers a device-independent, domain-independent, thus flexible and general purpose approach, able to address different food chains such as dairy, meat and fish, tea and coffee.

All data generated and collected in ASPIR are stored in the Data Base (DB).To provide the trust by using BC, ASPIR stores hash of data in the Ethereum BC. Each QR code is mapped to one record in the DB and a transaction in the BC. To store the data in the BC actors who generate QR codes need to have Ethereum accounts. By offloading the data in the DB, ASPIR reduces the cost of data storage in the SC, which is used for monitoring and the data integrity by ASPIR publicly.

III. DEMONSTRATION

For the demonstration, two main fully BC-enabled scenarios will be followed. At first, interactions of producers with ASPIR before a QR code generation will be shaown. These interactions include (a) adding, selection, and editing actions, and (b) the modification of producers' profile including licenses and product certificates.

The second scenario simulates a supply chain, where one product can be produced based on one or a combination of a set of products. Thus, a chain of products will be generated and the automated "connection" of products and the generated QR codes to previous ones are demonstrated. the end users' perspective will also be demonstrated by tracking one product can be done via the scanning of a QR code. Finally, the impact of BC integration in the data integrity verification will be presented. Users can and producers can monitor all transactions in the Ethereum block explorer while checking hashes in the system and by a block explorer matching.

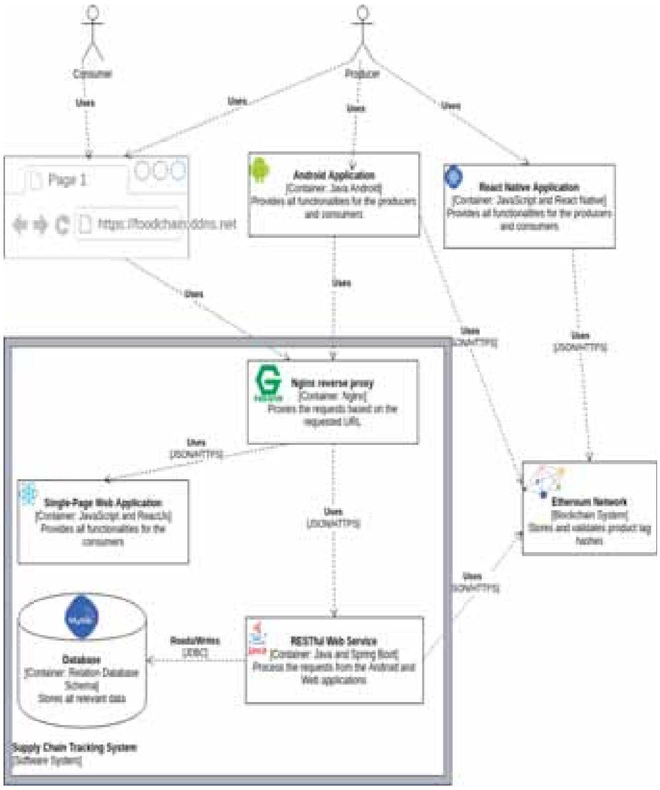

Fig. 2. ASPIR Context Diagram and Interaction Overview

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